Lubrication

NOVEMBER, 1915

Vol. III No. I

CONTENTS

Published by
THE TEXAS COMPANY
New York

LUBRICATION

Published by THE TEXAS COMPANY

All communications should be addressed to
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17 Battery Place, New York

VOL. III NOVEMBER, 1915 No. 1

We invite correspondence from all those interested.

Those who fail to receive LUBRICATION promptly, will please notify us at once and will confer a favor by promptly reporting change of address.

CONTENTS

For some time this little publication has been missing from your periodical list, not because we were unable to make the effort, but largely because a rearrangement of its scope, character and mailing list had become necessary.

It was obvious for some time that the scope of the magazine should be widened to take in some matters of importance to the buyer and user of lubricants, and that the number of issues should be increased to take care of the new material.

All this meant time and trouble in accumulation of material and investigation so that it was decided to suspend the publication of the magazine until arrangements for its issue under the new conditions had been perfected.

From this time on we hope to send your copy each month, with just enough reading matter to occupy the 15 minutes interval between work and home, or home and work, arranged so as to touch upon matters of definite interest to you as a user of lubricants.

From time to time we have received inquiries from many of our friends regarding the different tests which are referred to in some of the specifications for oil, or in some of the discussions of the subjects. These requests have induced us to arrange for a series of articles relating to the various tests and their value in connection with oil usage. Beginning with this number we are arranging for one of these articles, each month, until all the general tests and analyses have been covered.

The Diesel type of internal combustion engine is becoming more and more important in the power plant field, and a number of manufacturers in this country are now putting on the market engines of this type. The subject is an interesting one and one on which the progressive engineer will desire all the information available. For this reason we have arranged for a series of articles to appear from time to time, giving the general Diesel principles and operation, and detailing some of the well-known types of this engine manufactured in this country. The first of these articles will be found in this issue.

GRAVITY AND ITS APPLICATION TO THE USE OF OIL

For many years it has been customary to consider the gravity of an oil in connection with its use, and in some cases it was the only test required. While this habit has very properly fallen into disuse to a considerable extent in the last year or two, there are still a number of oil consumers who believe that gravity is a point to be considered in connection with its value for their purposes. There is still considerable confusion as to the value of the test and its purpose, and it is frequently called for in connection with the buying of oil where it has no bearing upon the value of the product in the actual performance of its work.

Gravity is the relative weight of any product compared with distilled water at the same temperature. Specific gravity is this comparison expressed in percentage of the weight of distilled water at a given temperature. Specific gravity is mentioned, therefore, as a decimal fraction when the material is lighter than water and as a whole number and a fraction when the material is heavier than water. For instance, if a given volume of an oil at a certain temperature weighs ¾ pounds and the same volume of water at the same temperature weighs 1 pound, the specific gravity of the oil will be indicated as .750. If on the other hand, some other material of a given volume and temperature weighs 1¼ pound and the same volume of distilled water under the same conditions weighs 1 pound, the specific gravity will be expressed as 1.250.

In addition to this specific method of stating gravity, there are various arbitrary scales adopted for the comparison of one product with another as to its gravity. The one which is used in the oil business in this country is the Baumé scale which is provided with markings indicating a certain gravity for products lighter than water, the lighter product showing a higher number and the heavier product showing a lower number.

In the laboratory, where it is necessary to secure the gravity of a product very accurately, an instrument known as the Westphal Balance is used, which measures the specific gravity of a product by weighing the product in comparison with water by means of a finely divided knife-edge balance. This method, however, is only necessary where a high degree of exactitude is required, and for all general purposes gravity is determined by a hydrometer, whether specific gravity, Baumé or other scale be required. The hydrometer is based upon the principle that if a solid is placed in a liquid it displaces exactly its own weight of the liquid. A hydrometer will consequently sink into the liquid to a greater degree when the liquid is lighter and to a smaller degree when the liquid is heavier. On the Baumé hydrometer the scale is so made that the number indicated by the graduation increases as the hydrometer sinks, and consequently a product which shows 32 on the Baumé hydrometer is lighter than a product which shows 16.

Crude oil is made up of a number of fractions which vary in weight so that when the oil is distilled the products secured from these different fractions have a different weight or gravity. The refiner who was dealing with one crude oil was able to determine that products of certain gravity from this crude

were valuable for certain purposes. For instance, gasoline made from his crude met the market requirements when it had an average gravity of a certain degree on the Baumé scale. As a consequence the refiner used the Baumé hydrometer to compare one batch of a product with another batch of the same product, and so long as gravity was used in this way it had a valuable purpose as an easy indication of the uniformity of the refiner's products.

Naturally enough, this same method of indicating the product secured from the same crude oil, extended rapidly beyond the refinery borders and became a general method of expressing a certain product in the trade. This was all right so long as the crude oils, from which were manufactured lubricating and other oils, were of the same chemical composition, from the same oil fields, and refined practically by the same processes. The discovery of new oil fields introduced the oil refiner to crude oils having different chemical compositions, and having different gravity in the crude itself, and consequently in its finished products. Some of these new crudes varied so much in chemical composition from the crude oil which had been used up to that time, that the methods of refining which were then understood could not be applied successfully to the distillation of the new crudes, and the first products secured from these new crudes were the result of experimentation upon a considerable scale. The oil user found that these products were not so suitable for his work as the ones which he had been buying from the well established refining units, and at the same time he observed that there was a difference in gravity, so that to protect himself he began to specify a gravity which would indicate an oil similar to what he had formerly been using.

Naturally the well established refineries which had been supplying lubricating oil up to that time, seized upon this opportunity to push the gravity test as a complete indication of value, and the use of this method was generally confirmed until it had become a thoroughly established trade practice. In the meantime, the study of new crudes and their possibilities had enabled the refiner of these new crudes to produce oils which possessed valuable characteristics for lubricating and other purposes, and in some cases possessed inherent advantages greater than could be secured from the older oil fields.

Methods of refining were properly adapted to the new requirements and products appeared on the market for all purposes equal and in some cases superior to the products previously available. These products, however, had entirely different gravities from the specifications formerly accepted, so it was not long before among the large buyers of oil the gravity question began to be left out as of no value.

The fact of the matter was that just as soon as gravity was used in an attempt to compare oils from different fields possessing different chemical and physical characteristics, it was being used as an indication of values which it was not capable of expressing. The mere fact that one oil for the same purpose is lighter or heavier than another oil can have no bearing upon its value as a fuel in an internal combustion engine, its burning quality in a lamp or its lubricating efficiency in a machine.

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the country, varying as much as eight degrees in gravity, vaporized just as rapidly in the carburetor and acted just as efficiently in the running of the motor, with the exception that there was more power to be secured per gallon from the lower gravity gasoline. Burning tests carried out in hundreds of cases have shown equally the absurdity of the gravity test, and in the lubricating field, in all kinds of plants, oils of 19 and 20 gravity have replaced oils of 30 and 32 gravity and have effectively performed the work.

Among large buyers of oil this is well understood, and in a great many cases specifications have been changed to meet new conditions or abandoned altogether.

A striking example of this change is indicated by the action of the U. S. Navy:

> "They formerly had specified only specific gravity for naphtha for their motor boats and launches, and soon were utterly handicapped in purchasing this in various parts of the world. For instance, while they could easily obtain a product of 70 degrees Baumé specific gravity on the eastern coast, this was an impossibility on the western coast and in other countries, because the Pacific and other western oils were very much heavier than Pennsylvania oils, although the gasoline and naphtha products obtained from them are equally volatile and perhaps more useful.
>
> "The volatility of two gasolines being equal, preference might well be given to the heavier one, as it has been shown recently that gasolines, which, for equal volatility have a higher percentage of carbon, are the most efficient, because they give a stronger expansion stroke......
>
> "At any rate, it is a fact, that the purchaser who buys gasoline by specific gravity alone, not only necessarily limits the source of supply (which, of course, raises the price), but frequently deprives himself of the better product."

Among small buyers and consumers there are still a great many who cling to the old gravity test in the belief that it will indicate the value of a product to meet the practical conditions of their work. This is largely because developments in the oil industry have not been brought to their attention, because it is customary for them to ask for a certain gravity in buying an oil, without in many cases making the test for gravity on the oil which has proved valuable

The situation of the last few years has brought into the market oils for lubricating purposes from a number of crudes so that oils varying widely in gravity are used for the same purpose. To meet this situation specifications (where they are still used) have been altered so that the limitations in gravity are sufficiently wide to be practically no specification at all. The fact of the matter is that so much depends upon the refining methods and processes in the manufacture of products from any crude for given purposes, that the care and resourcefulness of this manufacture is much more important to the oil user than any physical specification. The mere statement of the relative weight of the oil compared to water has nothing to do with its lubricating qualities under practical conditions, and the only valuable method of determining the practical usefulness of a product is the test under working conditions from the standpoint of consumption, decreased friction and saving in wear-and-tear.

The products of The Texas Company include oils manufactured from crude which is low in gravity, of intermediate gravity and of high gravity, so that where the customer desires to buy lubricating oils of a certain gravity we are able to supply his wants along those lines.

From our experience in the practical application of the lubricating oils which we manufacture we are able to state that gravity is not an indication in any way of the lubricating value of an oil, and should never be used in this connection. All Texaco products are manufactured from the crude which is the most suitable for the purpose for which the product will be used. The methods of refining are adapted to bring out the required characteristics and they are tested by our customers under practical conditions, so that their economy and service is an actual economy, produced under the conditions which they must meet in their every-day work for the consumer.

FROM A SALESMAN'S NOTE BOOK

While waiting at the office of one of my customers I looked through the gate and watched a man threading some large nickeled steel combination nuts with the aid of white lead and oil.

The operation was laborious and took considerable time.

When my interview was about over with the manager I inquired if I could see the man thread the large nuts and he said certainly. I immediately told them they could beat the present operation and they said it was impossible as they had tried everything.

I took an oil can and filled it from a sample of Extra Thread Cutting Oil and we started the machine. The way it worked was grand, they could turn out at least one-third more work and didn't have to contend with the objectionable white lead.

I got an order for a barrel on the spot.

The next day I met the foreman at the hotel and he said they had drilled four holes in a plate of chrome nickeled steel with it and thought it was great.

ABOUT ONE-HALF THE WEAR

Some months ago a very exhaustive and careful test was made in one of the plants supplying gas to serveral cities.

Two Snow Gas Engines were included in the test, one engine being lubricated with TEXACO and one with a competitive brand.

Careful observations were made at all points during the test, which ran through 1,172½ hours, and a number of valuable conclusions derived therefrom.

Out of the mass of data secured, however, one fact stands out as indicating the superior lubricating quality of TEXACO Oil.

The cylinders of each engine were calibrated at the beginning and end of the test, and the results showed wear on the cylinder from the competitive oil was almost *twice as great* as the wear when TEXACO Oil was used.

This test also showed an excessive carbon deposit in the engine lubricated with competitive oil, while the condition of the cylinder lubricated with TEXACO was good.

THE DIESEL ENGINE

"Paper read by Mr. W. F. Parish at the Annual Meeting of Lubricating Engineers and Superintendents of the Southern Territory of The Texas Company, Houston, November 9th, 1915."

The first experimental Diesel engine was built at Augsburg, Germany, by Dr. Rudolph Diesel, in 1893. This was a single cylinder, four-cycle, vertical engine of 20 H. P., having no air-supply pump, and the cylinders having no water-jacket. After about four years of laborious experimenting, a complete single cylinder, four-cycle, vertical engine of 18 H. P. was constructed. This Diesel engine remained the standard type, and the developments and alterations since that time have been in details of construction and in the size and number of cylinders.

During the following year, licenses were given to builders in all of the manufacturing countries of the world, and small engines up to 50 H. P. were built, these designs varying but little from the original German engine. Since this time Diesel engines have been built by the thousands in the best factories of all industrial countries, and have been set up in the most remote corners of the world. The engine has been rapidly developed in Germany, Sweden, England, Switzerland, Italy and France, until during the last ten years the steam engine manufacturers of Europe have practically ceased operation on steam engine building, the Diesel engine taking the place of all units up to 1000 H. P., and the turbine being installed for the largest plants. This development has been very rapid and very sensational. It is based on strong economic causes, and in the United States we undoubtedly shall see the same development during the next five years that has been going on in Europe.

Situation in America

At this writing, there are fifteen manufacturers of Diesel engines in the United States, who are prepared to furnish engines from 20 to 5000 H. P. The majority of these manufacturers have taken up the manufacture of Diesel engines only within the last two years. Previous to the expiration of the basic patents two years ago, only one concern in the United States was building Diesel engines. The type put out by this concern, while it embodied all of the most successful principles of the Diesel construction as far as the cylinders and valves went, differed from the European types in that the lubrication was secured through a water and oil bath on the principle employed by the builders of the Westinghouse Crank Case engine. This principle is now practically obsolete and the development of Diesel engines, which is now taking place, is based on designs which call for lubrication by either force or gravity systems.

To the uninitiated it may seem strange that the adoption of a certain lubricating system should in any way affect the material development of any piece of machinery. The fact remains, nevertheless, that the machines or engines that have prevailed and become well established as economical producers and performers have been so designed that the lubricating difficulties were practically eliminated. For years after the last Westinghouse steam and similarly lubricated engines with their splash water and oil baths have disappeared, they will be remembered by lubricating engineers because of the troubles that

were always encountered in their lubrication. The difficulty has been in maintaining exactly the proportion of the proper kind of water and oil to efficiently lubricate the machine; when the proportions vary, as they necessarily do in the course of operation, the mixture becomes either too thin for efficient lubrication or so thick that it forms a liver-like emulsion, and from an operating standpoint either of these effects is very undesirable.

Theoretical Basis

The Diesel engine is an attempt to realize, within the limitations of practice, an approach to the theoretical conditions of the Carnot cycle by the production of an internal combustion engine of very high thermal efficiency. In order to accomplish this result it was evident that a much higher degree of compression was necessary than that used in existing engines, since it was demanded that the charge be compressed so that all the heat resulting from compression be retained in the air compressed to the maximum initial pressure at which the engine was to be operated. Such a compression would naturally produce an increase in temperature sufficient to ignite the combustible, and hence it became apparent that the fuel must not be introduced with the air but that the air must first be compressed, building up its temperature rapidly, and that the fuel must then be introduced and burned during the outstroke of the piston, the heat being removed as rapidly as produced. This was the theoretical workout, and high efficiency could be thus secured if the desired cycle could be practically realized.

In discussing the theory of the subject the late Dr. Diesel laid down four conditions as essential to the realization of the highest economy; first, that the combustion temperature must be attained not by the combustion and during the same, but before and independent of it by the compression of pure air; second, that this is best accomplished by deviating from the pure Carnot cycle to the extent of combining two of the stages of the cycle and directly compressing the air, retaining all of the heat resulting from such compression; third, that the fuel be introduced gradually into the compressed air and burned with little or no increase in temperature during the period of combustion; fourth, that a considerable surplus of air be present.

Construction and Operation

In general construction the Diesel engine resembles the design of a vertical gas engine or an enclosed vertical marine engine, except that all parts are built to stand the high pressure employed. Compression is entirely independent of the quality of the fuel, for the simple reason that no fuel is introduced until it is wanted for ignition. Pure air alone is compressed, and therefore the intensity of compression is limited only by two factors—the ability of the mechanical construction to withstand the stresses, and the thermal possibilities involved.

In the operation of this engine use is made of the well-known physical property of air becoming heated when compressed. The compression in the Diesel engine cylinder is carried to such a point that a high temperature, 1000° F., and higher, is imparted to the air, and into this red hot temperature a liquid fuel is injected by air under still higher pressure. The compressed and highly heated air causes ignition of the injected fuel without any sudden explosion, and the burning process is gradual during the forward stroke of the piston.

The ignition is therefore made without any mechanical means, such as electrical or other sparking devices, hot balls, etc.

The Diesel engine operates on both the four-cycle principle and on the two-cycle principle. In the four-cycle type the engine receives a working impulse every other revolution, that is one power stroke to three strokes to complete the operation. In the two-cycle type it receives the power impulse on the first stroke of every revolution.

In the four-cycle type, on the down or intake stroke, the air is admitted through mechanically controlled air-inlet valves. On the up or return stroke, this air is compressed to about 450 to 500 pounds per square inch, and thereby becomes heated to a temperature of about 1000° F. A few degrees before the completion of this compression stroke, the liquid fuel is injected into the engine cylinder through the fuel oil injection valves and atomizers by means of highly compressed injection air furnished by an independent high pressure compressor. This high pressure injection air atomizes the oil completely and breaks it up into a mist which, on being mixed with the hot atmosphere of the engine cylinder, is burned and gasified. The gases force the piston down on the third or working stroke, expanding gradually very much as steam would expand in a cylinder after having been cut off. On the discharge stroke, or the fourth stroke, the burnt gases are expelled through the discharge or outlet valve into the exhaust pipe, or through the exhaust silencer into the atmosphere. This piston sweeps all the gases before it and acts as an efficient scavenger. The action of the engine as a scavenger pump during the fourth stroke is important, as the air taken in on the next stroke, that is the first stroke again, will not become mixed with any of the products of combustion, an occurrence which would not only decrease the efficiency of the engine but might cause preignition if any incompletely burned gases should be present.

The above cycles differ from that of a gasoline engine in three respects. In a gasoline engine, as the piston travels down during the admission stroke, a mixture of air and gasoline is carried into the cylinder by suction. On the second or up stroke this mixture is compressed. At the completion of this second stroke the mixture is fired with a spark which results in a positive explosion. The balance of the cycle of the gasoline engine is the same as in the Diesel type, consisting of the downward power stroke and the return upward or exhaust stroke.

The two-cycle engine receives two power impulses to one of the four-cycle engine, or one working or power stroke with every revolution. On this type of engine a scavenger pump operated directly from the main engine, or scavenger pistons, which are extensions of the power piston, furnish the air required for clearing the working cylinder of its burnt gases and for filling it with fresh air, which is then compressed on the return of the piston. At the time that the exhaust valves are open, air from the scavenger pump is admitted through mechanically operated valves at the piston end of the cylinder and sweeps before it the products of combustion, leaving the cylinder filled with fresh air, which is then compressed on the return stroke of the piston.

Gas or Gasoline Engine

Four-Cycle

1st Revolution......	Down Stroke	Suction of air and gas.
	Up Stroke	Compression of air and gas.
2nd Revolution.....	Down Stroke	Ignition and expansion power stroke
	Up Stroke	Exhaust.

Two-Cycle

1st Revolution...	Down Stroke	Ignition and expansion power stroke.
	Lower portion of Down Stroke	Exhausting gases and taking pure air in cylinders for cleaning, and air and gas charge.
	Up Stroke	Compression of charge.

Diesel Engine

Four-Cycle

1st Revolution......	Down Stroke	Suction of pure air.
	Up Stroke	Compression to 1000° F. temperature.
2nd Revolution.....	Down Stroke	Injection of fuel charge, ignition by contact with heated air, expansion, power stroke.
	Up Stroke	Exhaust of gases.

Two-Cycle

1st Revolution...	Down Stroke	Injection of charge and ignition by heated air.
	Lower portion of Down Stroke	Exhausting gases and taking in pure air for cleaning cylinders.
	Up Stroke	Compression of air to 1000° F.

The two-cycle engine, being more complicated than the four-cycle engine, and having fully 10 per cent higher fuel consumption, would be restricted in use to large engine units from 1000 H. P. upward and for large power plants. However, it has the advantage of saving considerably in weight, and for marine purposes, where saving in weight is of great importance, the four-cycle engine is limited to small units. The two-cycle engine is also less complicated where reversing is necessary as in marine work.

The fuel used for operating Diesel engines can run all the way from light petroleum distillate to the very heaviest residual oil. The fuel is introduced into the engine by means of compressed air of from 700 to 900 pounds pressure, which is supplied by a two-stage air compressor and carried in "bottles" holding sufficient compressed air for starting the engine. The amount of fuel injected is regulated by a governor which is operated by the load. Various types and many designs of atomizers or admission valves are used for the purpose of atomizing the oil.

Economy

In small steam plants with simple engines operating non-condensing, the amount of heat energy utilized out of that contained in the fuel is

Working Diagrams of Single-acting Diesel Engines.

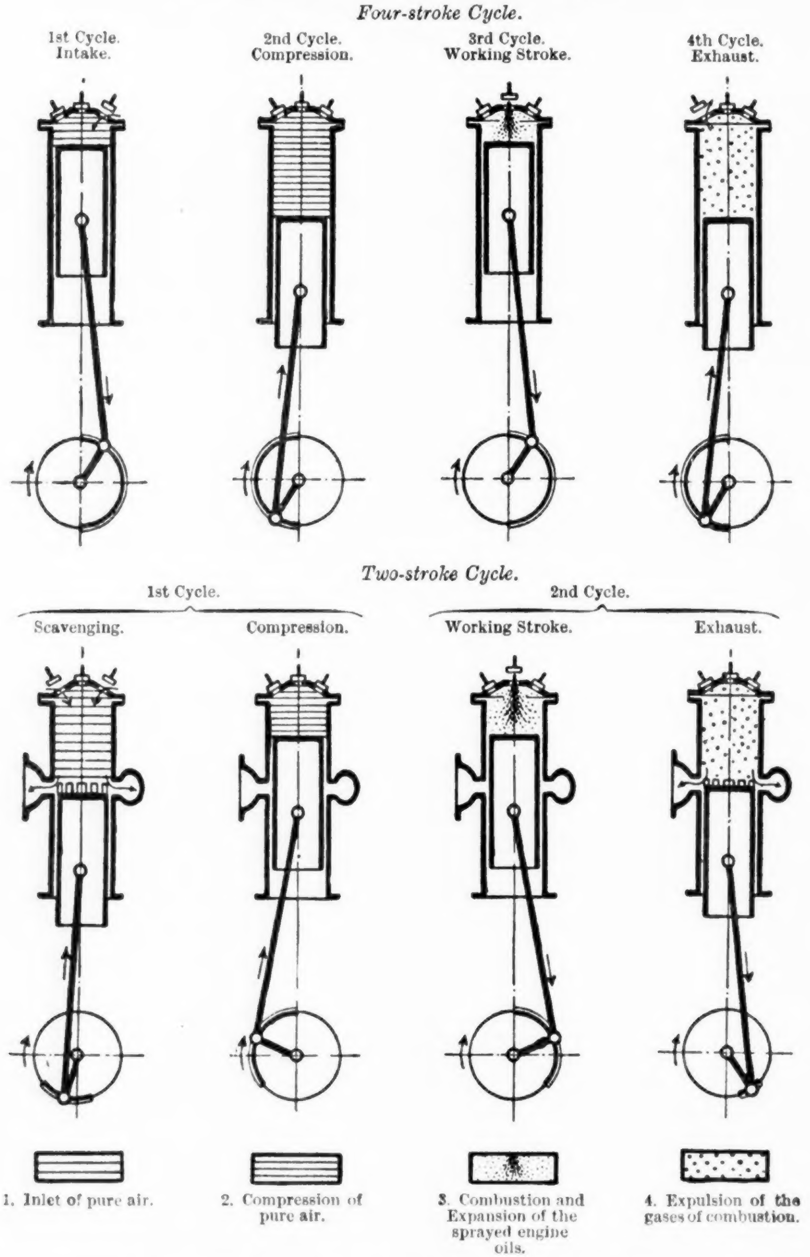

Diagram from an article written by the late DR. RUDOLPH DIESEL of MUNICH
Published by THE INSTITUTION OF MECHANICAL ENGINEERS of LONDON

6 per cent (this is the thermal efficiency); with compound condensing engines 10 per cent, while triple expansion condensing engines having the most modern boilers, economizers, heaters, and all equipment, will only utilize 15 per cent to 18 per cent of the heat value of the fuel. The Diesel engine will utilize 32 per cent to 35 per cent of the heat value of the fuel; that is to say, they will develop the same amount of power with from one-third to two-fifths of the amount of fuel oil used by modern steam plants. This high efficiency of the Diesel engine is largely due to the high compression which is possible only with the Diesel system of fuel admission and to the thorough breaking up of the oil by being introduced under high pressure.

It is well known that slide valve engines or steam pumps with single cylinders are very wasteful of steam. The fact that such an engine utilizes only 6 per cent of the heat energy of the coal or fuel oil used under the boiler is rarely considered. It is a fact, however, that 100 per cent increased efficiency between a plain rotary valve engine and a triple expansion engine has been the reason for the installation of the latter type in practically all the large power plants or steam ships where such an engine is workable. Considering the results given in the following table in the light of the necessity of conservation of natural fuels, it will immediately appear that there is practically no excuse whatever for the existence of slide valve or even the more complicated types of steam engines, especially when as highly efficient an engine as the Diesel has been developed.

The following table shows the comparative thermal efficiency of prime movers:

TYPE OF PLANT	B. T. U. Per B.H.P.Hour	Thermal Efficiency
Non-condensing Steam Engine.	30,000 to 38,000	8.4% to 6.6%
Condensing Steam Engine and Turbine using superheated steam at 150 lbs. pressure	17,000 to 25,000	15% to 10%
Diesel Engines..............	7,500 to 8,000	35% to 32%

A fair average consumption in a Diesel engine on the basis of brake horse-power per hour when using fuel with a heating capacity of 18,500 B. T. U. per pound can be taken as 0.40 pounds per H. P. Hour for the largest engine, and 0.46 pounds for the smaller engines. On the above basis, considering the oil weighs 7.5 pounds per gallon, the fuel consumption per 100 B. H. P. hours would be about six gallons. A number of cases are on record where steam plants, consisting of boilers, economizers, pumps, engines, and condensers, have been removed and the same horse-power of Diesel engines installed in the same room to take up the load, and the saving in fuel alone has in a few years paid for the investment. One record of comparative economy, which occupied much space in the technical literature on the subject, was the double plant built by the France Tosi Company, Milan, and put in the Turin Exposition in 1911. This plant consisted of a modern steam turbine taking steam from boilers filled with the best fuel oil burners and having the same power as a Diesel engine built by the same company. Both plants ran side by side for comparative purposes with the general result that the steam plant required two and one-half times the weight

of fuel oil required by the Diesel engine, the ratio being twenty-five to ten in favor of the Diesel engine.

It should be stated that inasmuch as the oil is burned directly in the Diesel engine operating the air compressor and air pump, it represents the total fuel used per brake horse-power. Therefore, the comparison with the steam engine must also be on the basis of total fuel consumption per brake horse-power so as to include boiler losses, power required for auxiliaries, boiler feed, vacuum and circulating pumps and the large heat losses in condensing. Another remarkable characteristic of a properly designed and well built Diesel engine is the slight increase in the fuel consumption when operating at fractional loads. Thus with a total thermal efficiency of 35 per cent at full load it remains 33 per cent at a three-quarter load, and drops only to 28 per cent at half load. The low fuel consumption secured with the Diesel engine under test conditions is only slightly exceeded in actual operation under average operating conditions. In this respect it differs radically from steam and producer gas power plants, the full consumption of which, during extended operating periods, which include stand-by and banking losses, greatly exceeds that guaranteed and secured under test conditions.

The economy of the Diesel engine, however, depends not alone upon its thermal efficiency and fuel economy. Economy of space, fuel and attendance, elimination of all stand-by expenses, its fuel consumption from half load to 10 per cent overload almost in direct proportion to the load carried, and its readiness to start cold at a moment's notice, are responsible for its unprecedented efficiency and economy. Diesel engines eliminate coal bunkers, stacks, pump-room and boiler-room auxiliaries. They eliminate incompetent and careless stoking, firing, draft and water regulations, losses which even in well regulated steam plants commonly amount to from 15 per cent to 30 per cent of the value of the coal. They eliminate the varying factors to which coal is subject, its varying percentages of ash and oxygen, and also calorific deterioration due to storage, which in half a year may amount to 12 per cent. The Diesel engine also uses less water than required for the operation of the producer gas engines or condensing steam plants of like power.

A further advantage of the Diesel engine is its flexibility, that is its ability to meet overloads or the return to lighter loads readily. The fuel supply is controlled solely by means of a sensitive governor, by which the rate of the fuel injection is instantly modified to meet momentary load requirements. In the Diesel plant the human element and the skill of the operator has much less influence upon the fuel economy than in the steam or producer gas plant where everything depends upon the efficiency and intelligence of the fireman and producer attendant.

The lubrication of the Diesel engine is of prime importance. From the fact that in vertical Diesel engines a considerable proportion of the cylinder oil drains back into the circulating oil system, only one oil is desirable, and this oil must be pre-eminently suitable for the cylinders.

The two 2500 H. P. government built engines for the Collier "Maumee" were started up and tested out on Teaxco Ursa Oil which was used on the high pressure lubricating system for the cylinder compressors and all upper reciprocating parts and guides, and through the low pressure lubricat-

ing system for the bearings, crank and cross head pins. From the moment of starting these engines not a particle of difficulty was caused through lubrication.

The 500 H. P. Busch-Sulzer Bros. Diesel engine, which was built at St. Louis, and which was started by President Wilson at the San Francisco Fair the first of 1915, was lubricated with Texaco Ursa Oil for the entire engine with complete satisfaction.

Many other Diesel engines of other makes in many lines of work are being lubricated with Texaco Ursa Oil, this oil handling this difficult problem with the greatest efficiency.

CURES CYLINDER TROUBLES WITH TEXACO

In a Water Works plant in the Middle West, some pumps which were installed about a year ago were giving considerable trouble.

These pumps were to be used mainly in case of fire and designed to maintain a high pressure, but difficulty was encountered in maintaining this pressure.

From time to time engineers from the pump company were called in, and finally a consulting engineer was engaged. Nevertheless the trouble continued.

Sometime ago TEXACO Summit Valve Cylinder Oil and TEXACO Nabob Engine Oil were put in on these units. Up to the present time there has been no recurrence of the trouble and during a recent fire test the pressure held up satisfactorily.

The consumption of oil has been reduced.

90 POUNDS INSTEAD OF 350 POUNDS

TEXACO Crater Compound scored a great success in one of the large Western plants recently.

In this plant is installed a large automatically controlled electric blowing and elevating engine, with two driving gears six feet in diameter by nine inches face.

The extremely high speed and pressure to which these gears are subjected, has made the problem of lubrication a very serious one.

Before Crater Compound was introduced they had been accustomed to using 350 pounds of competitive gear grease per month on good running.

With TEXACO Crater Compound the gears have been thoroughly lubricated with 90 pounds per month, and the results are eminently satisfactory.

RAND McNALLY & CO., NEW YORK